Claims

What is claimed is:

1. A method comprising using a layered manufacturing process to produce an article having at least one small-width fluid conduction vent, wherein at least one of said small-width fluid conduction vent or vents has a non-circular cross-sectional shape and is produced in said article by said layered manufacturing process.

2. The method of claim 1, wherein at least one of said small-width fluid conduction vent or vents has a polygonal cross-sectional shape.

3. The method of claim 2, wherein at least one of said small-width fluid conduction vent or vents has at least one of a square cross-sectional shape and a hexagonal cross-sectional shape.

4. The method of claim 1, wherein at least one of said small-width fluid conduction vent or vents varies in width along its center line.

5. The method of claim 1, wherein at least one of said small-width fluid conduction vent or vents varies in cross-sectional shape along its center line.

6. The method of claim 1, wherein at least one of said small-width fluid conduction vent or vents has a non-straight center line.

7. The method of claim 1, further comprising the steps of:

a) providing a layer of powder; and

b) printing a layer of said article by binding together said powder in pre-selected areas of said layer of powder.

8. The method of claim 7, wherein said powder includes at least one selected from the group consisting of a metal, a ceramic, a polymer, and a composite.

9. The method of claim 1, wherein at least one of said small-width fluid conduction vent or vents has a width in the range of between about 0.02 cm and about 0.25 cm.

10. The method of claim 1, further comprising the step of creating an electronic representation of said article with at least one of said small-width fluid conduction vent or vents positioned within said article.

11. The method of claim 10, further comprising the steps of:

a) providing an algorithm; and

b) executing said algorithm on a computer to do at least one of the following:

i) design at least one of said small-diameter fluid conduction vent or vents;

ii) select a location for at least one of said small-diameter fluid conduction vent or vents within said article;

iii) select an array density for a plurality of said small-diameter fluid conduction vents for at least a portion of a surface of said article;

iv) incorporate an electronic representation of at least one of said small-diameter fluid conduction vent or vents into an electronic representation of said article; and

v) cause said article to be printed in a layer-by-layer manner.

12. The method of claim 1, further comprising the steps of:

a) creating a first electronic file containing a representation of said article, wherein at least one of said fluid conduction vent or vents is absent from the representation of said article;

b) creating a second electronic file containing a representation of at least one of said absent small-width fluid conduction vent or vents; and

c) combining said first electronic file with said second electronic file to create a third electronic file containing a representation of said article with at least one of said absent small-width fluid conduction vent or vents positioned within said article.

13. The method of claim 1, wherein said article is a component of an EPS bead mold.

14. The method of claim 13, further comprising the steps of:

a) using said article to make a pattern; and

b) using said pattern in a lost-foam molding process.

15. The method of claim 1, wherein said article is a component of at least one selected from a group consisting of an injection mold, a vacuum forming tool, a heat transfer device, and a fluid regulating device.

16. The method of claim 1, further comprising the step of using said article in at least one selected from a group consisting of an EPS bead molding process, an injection molding process, a vacuum forming process, a heat transfer device, and a fluid regulating device.

17. The method of claim 1, further comprising the step of orienting at least one of said small-width fluid conduction vent or vents in a direction that is not substantially normal to a surface at which said small-width fluid conduction vent terminates.

18. The method of claim 17, wherein said article has a plurality of small-width fluid conduction vents and is a component of a multi-piece mold having a direction of opening in use, wherein the step of orienting includes orienting at least one of said plurality of small-width fluid conduction vents to have a center line oriented parallel to said direction of opening.

19. The method of claim 1, further comprising the step of infiltrating said article with an infiltrant.

20. The method of claim 19, wherein said infiltrant is a metal.

21. The method of claim 20, wherein said infiltrant is bronze.

22. The method of claim 1, wherein said layered manufacturing process is a three-dimensional printing process.

23. The method of claim 22, wherein at least one of said small-width fluid conduction vent or vents has a polygonal cross-sectional shape.

24. The method of claim 22, wherein at least one of said small-width fluid conduction vent or vents varies in width along its center line.

25. The method of claim 22, wherein at least one of said small-width fluid conduction vent or vents varies in cross-sectional shape along its center line.

26. The method of claim 22, further including the steps of:

a) providing a layer of powder comprising a metal powder; and

b) printing a layer of said article by depositing a binder on said layer of powder to bind together said metal powder in pre-selected areas of said layer of powder.

27. The method of claim 22, wherein said binder comprises at least one of a polymer and a carbohydrate.

28. The method of claim 26, wherein said metal powder comprises a stainless steel powder.

29. The method of claim 22, further comprising the step of infiltrating said article with an infiltrant.

30. The method of claim 29, wherein said infiltrant comprises a metal.

31. The method of claim 1, wherein said layered manufacturing process is a selective laser sintering process.

32. The method of claim 31, wherein at least one of said small-width fluid conduction vent or vents has a polygonal cross-sectional shape.

33. The method of claim 31, wherein at least one of said small-width fluid conduction vent or vents varies in width along its center line.

34. The method of claim 31, wherein at least one of said small-width fluid conduction vent or vents varies in cross-sectional shape along its center line.

35. The method of claim 31, further including the steps of:

a) providing a layer of powder comprising a metal powder and a binder; and

b) printing a layer of said article by scanning a laser beam over said layer of powder to cause said binder to bind together said metal powder in pre-selected areas of said layer of powder.

36. The method of claim 31, further comprising the step of infiltrating said article with an infiltrant.

37. The method of claim 36, wherein said infiltrant comprises a metal.

38. An article produced by the method described in claim 1.

39. An article produced by the method described in claim 3.

40. An article produced by the method described in claim 6.

41. An article produced by the method described in claim 7.

42. An article produced by the method described in claim 9.

43. An article produced by the method described in claim 13.

44. An article produced by the method described in claim 17.

45. An article produced by the method described in claim 18.

46. A method comprising using a layered manufacturing process to produce an article having at least one small-width fluid conduction vent, wherein at least one of said small-width fluid conduction vent or vents has a non-straight center line and is produced in said article by said layered manufacturing process.

47. The method of claim 46, wherein at least one of said small-width fluid conduction vent or vents has a non-round cross-sectional shape.

48. The method of claim 47, wherein at least one of said small-width fluid conduction vent or vents has a polygonal cross-sectional shape.

49. The method of claim 48, wherein at least one of said small-width fluid conduction vent or vents has at least one of a square cross-sectional shape and a hexagonal cross-sectional shape.

50. The method of claim 46, further comprising the steps of:

a) providing a layer of powder comprising a powder; and

b) printing a layer of said article by binding together said powder in pre-selected areas of said layer of powder.

51. The method of claim 50, wherein said powder includes at least one selected from the group consisting of a metal, a ceramic, a polymer, and a composite.

52. The method of claim 46, wherein at least one of said small-width fluid conduction vent or vents has a width in the range of between about 0.02 cm and about 0.25 cm.

53. The method of claim 46, further comprising the step of creating an electronic representation of said article with at least one of said small-width fluid conduction vent or vents positioned within said article.

54. The method of claim 53, further comprising the steps of:

a) providing an algorithm; and

b) executing said algorithm on a computer to do at least one of the following:

i) design at least one of said small-diameter fluid conduction vent or vents;

ii) select a location for at least one of said small-diameter fluid conduction vent or vents within said article;

iii) select an array density for a plurality of said small-diameter fluid conduction vents for at least a portion of a surface of said article;

iv) incorporate an electronic representation of at least one of said small-diameter fluid conduction vent or vents into an electronic representation of said article; and

v) cause said article to be printed in a layer-by-layer manner.

55. The method of claim 46, further comprising the steps of:

a) creating a first electronic file containing a representation of said article, wherein at least one of said fluid conduction vent or vents is absent from the representation of said article;

b) creating a second electronic file containing a representation of at least one of said absent small-width fluid conduction vent or vents; and

c) combining said first electronic file with said second electronic file to create a third electronic file containing a representation of said article with at least one of said absent small-width fluid conduction vent or vents positioned within said article.

56. The method of claim 46, wherein said article is a component of an EPS bead mold.

57. The method of claim 56, further comprising the steps of:

a) using said article to make a pattern; and

b) using said pattern in a lost-foam molding process.

58. The method of claim 46, wherein said article is a component of at least one selected from a group consisting of an injection mold, a vacuum forming tool, and a fluid regulating device.

59. The method of claim 46, further comprising the step of using said article in at least one selected from a group consisting of an EPS bead molding process, an injection molding process, a vacuum forming process, and a fluid regulating device.

60. The method of claim 46, further comprising the step of infiltrating said article with an infiltrant.

61. The method of claim 60, wherein said infiltrant is a metal.

62. The method of claim 61, wherein said infiltrant is bronze.

63. The method of claim 46, wherein said layered manufacturing process is a three-dimensional printing process.

64. The method of claim 63, further including the steps of:

a) providing a layer of powder comprising a metal powder; and

b) printing a layer of said article by depositing a binder on said layer of powder to bind together said metal powder in pre-selected areas of said layer of powder.

65. The method of claim 64, wherein said binder comprises at least one of a polymer and a carbohydrate.

66. The method of claim 63, further comprising the step of infiltrating said article with an infiltrant.

67. The method of claim 46, wherein said layered manufacturing process is a selective laser sintering process.

68. The method of claim 67, further including the steps of:

a) providing a layer of powder comprising a metal powder and a binder; and

b) printing a layer of said article by scanning a laser beam over said layer of powder to cause said binder to bind together said metal powder in pre-selected areas of said layer of powder.

69. The method of claim 67, further comprising the step of infiltrating said article with an infiltrant.

70. The method of claim 69, wherein said infiltrant comprises a metal.

71. An article produced by the method described in claim 46.

72. An article produced by the method described in claim 47.

73. An article produced by the method described in claim 48.

74. An article produced by the method described in claim 50.

75. An article produced by the method described in claim 56.

76. An article produced by the method described in claim 58.

77. A method comprising using a layered manufacturing process to produce an article having at least one small-width fluid conduction vent, wherein at least one of said small-width fluid conduction vent or vents is branched and is produced in said article by said layered manufacturing process.

78. An article produced by the method described in claim 77.

79. A method comprising using a layered manufacturing process to produce an article having at least one small-width fluid conduction vent, wherein at least one of said small-width fluid conduction vent or vents has a polygonal cross-sectional shape and is produced in said article by said layered manufacturing process.

80. The method of claim 79, wherein at least one of said small-width fluid conduction vent or vents has a square cross-sectional shape.

81. A method comprising using a layered manufacturing process to produce an article having at least one small-width fluid conduction vent, wherein at least one of said small-width fluid conduction vent or vents varies in width along its center line and is produced in said article by said layered manufacturing process.

82. A method comprising using a layered manufacturing process to produce an article having at least one small-width fluid conduction vent, wherein at least one of said small-width fluid conduction vent or vents varies in cross-sectional shape along its center line and is produced in said article by said layered manufacturing process.

83. An article produced by the method described in claim 79.

84. An article produced by the method described in claim 80.

85. An article produced by the method described in claim 81.

5

86. An article produced by the method described in claim 82.